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The efficacy of microendoscopic discectomy in reducing iatrogenic muscle injury

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Object. The objective of this study was to evaluate the invasiveness of microendoscopic discectomy (MED) in comparison with microscopic discectomy (MD) by measuring serum levels of creatine phosphokinase (CPK)-MM and lactate dehydrogenase (LDH)-5, and by comparing visual analog scale (VAS) scores of postoperative pain.

Methods. This study included a group of 15 patients who underwent surgery using MED and 15 patients who underwent surgery using MD, both for single-level unilateral herniated nucleus pulposus. The CPK-MM and LDH-5 levels were measured at admission and after 1, 3, and 5 days postoperatively. Pain assessment was recorded using scores raging from 0 to 10 on a subjective VAS at admission and at 1, 3, and 5 days postoperatively.

Results. The mean CPK-MM levels were lower for the MED group than for the MD group at both 3 (576.1 $\pm$ 286.3 IU/L compared with 968.1 $\pm$ 377.8 IU/L) and 5 days (348.1 $\pm$ 231.0 IU/L compared with 721.7 $\pm$ 463.2) postoperatively ($p < 0.05$). The mean VAS scores for postoperative back pain were lower in the MED group than in the MD group, both at 1 (3.3 $\pm$ 2.3 compared with 5.8 $\pm$ 1.5) and 5 days (1.9 $\pm$ 1.1 compared with 3.6 $\pm$ 1.1) postoperatively ($p < 0.01$).

Conclusions. The MED procedure is less invasive than MD, and causes less muscle damage and less back pain.
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Key Words • creatine phosphokinase • intervertebral disc displacement • lactate dehydrogenase • microendoscopic discectomy • microscopic discectomy • minimally invasive surgery

In 1934, Mixter and Barr[11] reported on a transdural discectomy procedure used to treat intervertebral disc herniation. In 1939, Love[10] reported on a refinement of this approach using an extradural route. Since then, open discectomy has become the gold standard of surgical treatment for intervertebral disc herniation. A great deal of evidence, however, supports the claim that back muscles are damaged during open discectomy, resulting in muscle atrophy and segmental instability.[5,7] In 1977, Caspar[1] introduced use of the microscope to the discectomy procedure to enable enhanced visualization and a reduction in the size of the skin incision. Caspar used a muscle-splitting technique to expose the lamina. The initial MD evolved into the procedure in which the paravertebral muscle is detached from the spine subperiosteally and retracted using a retractor; however, MD still injures the paravertebral muscle by the detachment and retraction of the muscle. Twenty years later, Foley and Smith[3] introduced the MED procedure, which involves a tubular retractor system, a rigid endoscope, and a video monitor system.

The major difference between MED and MD is that an endoscope with a small tubular retractor is used in MED, whereas a microscope with a muscle-reflecting retractor is used in MD. Compared with conventional open discectomy, MED supposedly requires smaller incisions, causes less muscular damage, and creates less irritation to the nerve root.[4,12,13,15] Although a number of authors report that MED results in a shorter hospital stay and a quicker return to work than comparable procedures, there is a lack of objective evidence to support these claims. The objective of this study was to evaluate the invasiveness of MED in comparison with MD by measuring serum levels of CPK-MM and LDH-5, and by comparing VAS scores of postoperative pain.

Abbreviations used in this paper: BMI = body mass index; CPK = creatine phosphokinase; LDH = lactate dehydrogenase; MED = microendoscopic discectomy; MD = microscopic discectomy; VAS = visual analog scale.

Clinical Material and Methods

Patient Selection

This study involved 30 patients who underwent lumbar discectomy at our institute between April and July 2004. All participating patients had clinical presentations and neurological examinations consistent with a single-level unilateral herniated nucleus pulposus, which was refractory to more than 6 weeks of conservative management. These diagnoses were verified using imaging studies such as computed tomography scans and magnetic resonance imaging. Patients were excluded for the following conditions: spinal stenosis or previous disc surgery at such levels; elevated serum CPK-MM and LDH-5 levels during the preoperative period; muscular dystrophy, myositis, or rhabdomyolysis; and using medications such as statins that can elevate serum CPK-MM levels. Patients were randomly assigned to an MED or MD group by a random number generator. If the number was odd, the patient was assigned to the MED group; if the number was even, the patient was assigned to the MD group. The operations were all performed at the same institution using the same surgical technique by the same neurosurgeon (D.A.S.).

Perioperative Management

All patients were administered midazolam and glycopyrrolate 1 hour before surgery. Anesthesia was induced using 2.5 mg/kg of propofol and 2 μg/kg of fentanyl; 0.1 mg/kg of vecuronium was injected intravenously for muscle relaxation. Anesthesia was maintained using sevoflurane and 66% NO in O_2. The patients were placed prone on a spine table (Wilson frame, Mizuho OSI) with their abdomens free, to reduce intraoperative venous bleeding. Additionally, all pressure points were sufficiently padded to avoid pressure sores and muscle compression. Before the surgical incision was made, skin and subcutaneous tissue were infiltrated with 5 mL of 1% lidocaine containing a ratio of 1:200,000 adrenaline to cause local vasoconstriction. All patients received the same postoperative pain management medication, which included 200 mg of nimesulide (Choongwae Pharma Corporation) for postoperative daily analgesia. Patient-controlled analgesia was used for the first 2 postoperative days. Intramuscular injections were prohibited to prevent unwanted muscle injury.

Microendoscopic Discectomy Procedures

For patients in the MED group, first-generation MED instrumentation (Medtronic Sofamor Danek) was used. A 2.0-cm-long skin incision was made, 1.5 cm from the midline. Under fluoroscopic guidance, a guide pin was inserted and directed toward the inferior aspect of the lamina, and the facet complex was placed over the disc space. The first dilator was passed over the guide pin, and then the guide pin was removed so as not to penetrate the dura mater. The remaining dilators were passed sequentially. The underlying muscles were split along their fibers rather than torn. A 16-mm working channel was passed over the final dilator and angled slightly medially. An endoscope angled at 30° was then attached to the working channel and a hemipartial laminectomy, a flavectomy, and a discectomy were performed. After meticulous hemostasis was performed, the working channel with the attached endoscope was slowly removed, and the fascia and subcutaneous tissue were closed with absorbable suture materials to avoid later stitch removal. During these operations, nucleus pulposus protrusion was observed in all patients, confirming the preoperative diagnosis.

Microscopic Discectomy Procedures

Standard surgical procedures, consisting of a hemipartial laminectomy and discectomy, were performed according to the method described by Love.[10] A 4.0-cm-long midline skin incision was made. After the incision of the paramedian fascia, a subperiosteal muscle dissection was performed. The paravertebral muscles were swept over the facet joint using a Taylor retractor. With microscopic visualization, a hemipartial laminectomy, a flavectomy, and a discectomy were performed. Meticulous hemostasis was performed using a bipolar coagulator instead of inserting a hemovac. After hemostasis, the fascia and subcutaneous tissues were closed using absorbable suture materials to avoid later stitch removal. During the operations, nucleus pulposus protrusion was observed in all patients, confirming the preoperative diagnosis.

Blood Sampling and Postoperative Evaluation

The CPK-MM and LDH-5 serum levels were measured in 3 mL of arterial blood obtained from a catheter, which had been placed in the radial artery to monitor blood pressure and blood gas in the operating room. These levels were measured at admission and 1, 3, and 5 days postoperatively. Postoperative evaluation was performed by the pain specialist nurse who was blinded to the patients' treatment. Patients, who were blinded to their treatment, were asked to grade their pain intensity during admission, and at the first, third, and fifth day after their operation. Pain assessment was recorded by patients as a score from 0 to 10 using a subjective VAS, in which a score of 0 represented no pain and a score of 10 represented the worst pain imaginable.

Statistical Analysis

The results were reported as means ± standard deviations. Statistical analysis was performed using the Mann–Whitney U-test, and the results were considered statistically significant if the probability value was less than 5% ($p < 0.05$).

Results

Patient Demographics

In the MED group, there were 15 patients (7 male, 8 female) with a mean age of 42.7 ± 17.7 years and a mean BMI of 23.1 ± 2.1. The mean operation time was 49 ± 5 minutes and the mean volume of bleeding was 35 ± 9 mL. In the MD group, there were 15 patients (5 male, 10 female) with a mean age of 48.1 ± 10.6 years and a mean BMI of 22.7 ± 1.5 (Table 1). The mean operation time was 47 ± 5 minutes and the mean volume of bleeding was 34 ± 11 mL. There were no significant differences between the two groups with regard to age ($p = 0.389$), BMI ($p = 0.487$), operation time ($p = 0.148$), and volume of bleeding ($p = 0.081$).

TABLE 1

Summary of patient demographics in the two treatment groups

Factor	MED	MD
number of cases	15	15
sex (M/F)	7:8	5:10
age (yrs)	42.7 ± 17.7	48.1 ± 10.6
BMI	23.1 ± 2.1	22.7 ± 1.5
affected levels (no. of pts)		
L4–5	9	8
L5–S1	6	7
mean operation time (min)	49 ± 5	47 ± 5
mean bleeding volume (mL)	35 ± 9	34 ± 11

Muscle Enzymes

The mean CPK-MM levels for the MED group were 49.8 ± 5.9 IU/L at admission, 422.7 ± 318.1 IU/L 1 day postoperatively, 576.1 ± 286.3 IU/L 3 days postoperatively, and 348.1 ± 231.0 IU/L 5 days postoperatively. For the MD group, the equivalent values were 48.3 ± 5.6 IU/L, 620.9 ± 178.8 IU/L, 968.1 ± 377.8 IU/L, and 721.7 ± 463.2 IU/L, respectively. The mean CPK-MM levels were lower for the MED group than for the MD group at both 3 and 5 days postoperatively ($p < 0.05$; Fig. 1). The mean LDH-5 levels for the MED group were 11.2 ± 0.7 IU/L at admission, 18.4 ± 8.9 IU/L 1 day postoperatively, 18.8 ± 8.7 IU/L 3 days postoperatively, and 25.1 ± 12.5 IU/L 5 days postoperatively. For the MD group, the equivalent values were 11.0 ± 0.6 IU/L, 18.5 ± 10.8 IU/L, 19.7 ± 9.5 IU/L, and 27.2 ± 13.5 IU/L, respectively. These differences were not statistically significant (Fig. 2).

Postoperative Pain

The mean VAS scores for back pain in the MED group were 7.5 ± 2.4 on admission, 3.3 ± 2.3 one day postoperatively, 3.1 ± 2.6 three days postoperatively, and 1.9 ± 1.1 five days postoperatively. For the MD group, the equivalent scores were 8.6 ± 1.6, 5.8 ± 1.5, 4.7 ± 1.8, and 3.6 ± 1.1, respectively. The mean VAS scores for postoperative back pain were lower in the MED group than in the MD group, both at 1 and 5 days postoperatively ($p < 0.01$; Fig. 3). The mean VAS scores for leg pain in the MED group were 7.7 ± 2.2 on admission, 3.5 ± 2.6 one day postoperatively, 3.3 ± 1.2 three days postoperatively, and 2.5 ± 1.6 five days postoperatively. For the MD group, the equivalent scores were 7.9 ± 2.6, 3.9 ± 2.8, 3.8 ± 2.6, and 2.4 ± 2.1, respectively. These differences were not statistically significant (Fig. 4).

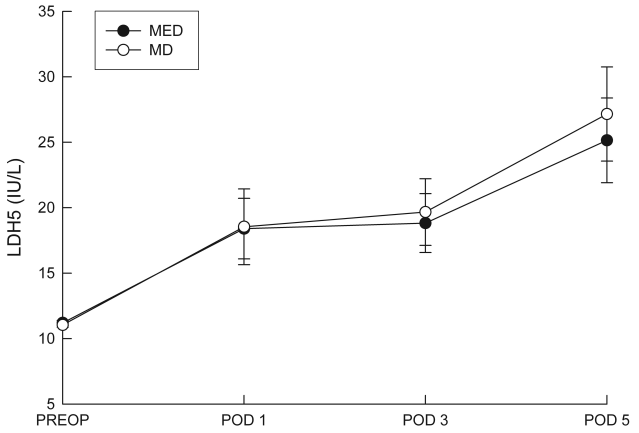

FIG. 2. Line graph showing no significant differences in LDH-5 serum levels between the two treatment groups at any time point.

Discussion

The aim of this study was to evaluate the invasiveness of MED compared with that of MD by measuring serum CPK-MM and LDH-5 levels and by comparing VAS scores

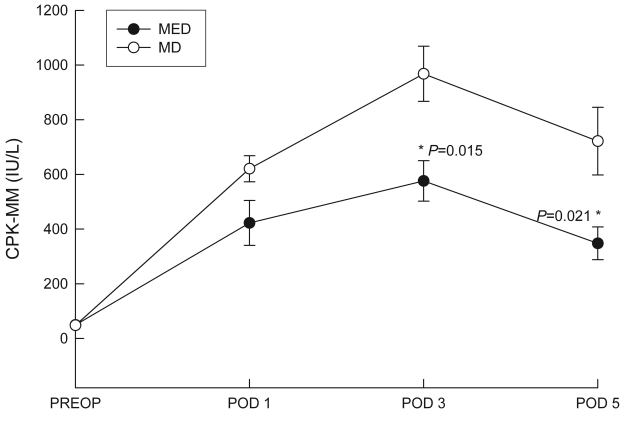

FIG. 1. Line graph showing differences in mean CPK-MM serum levels between the two treatment groups. Mean CPK-MM serum levels increased after surgery and reached a peak 3 days postoperatively. The mean serum CPK-MM levels of the MED group were significantly lower than those of the MD group at both 3 ($p = 0.015$) and 5 days ($p = 0.021$) postoperatively.

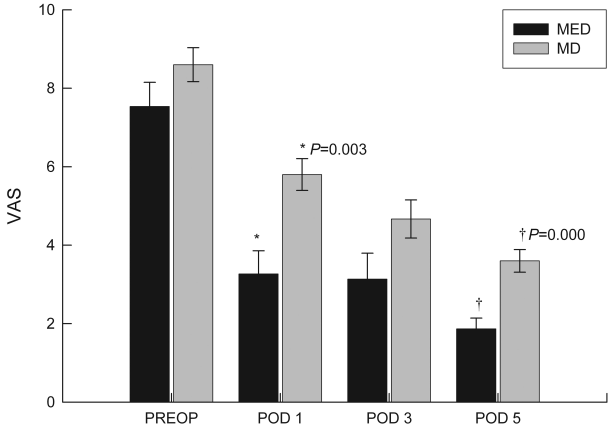

FIG. 3. Bar graph showing preoperative and postoperative differences in VAS scores of back pain between the two treatment groups. The mean VAS scores of the MED group were significantly lower than those of the MD group at both 1 ($p = 0.003$) and 5 days ($p = 0.00$) postoperatively.

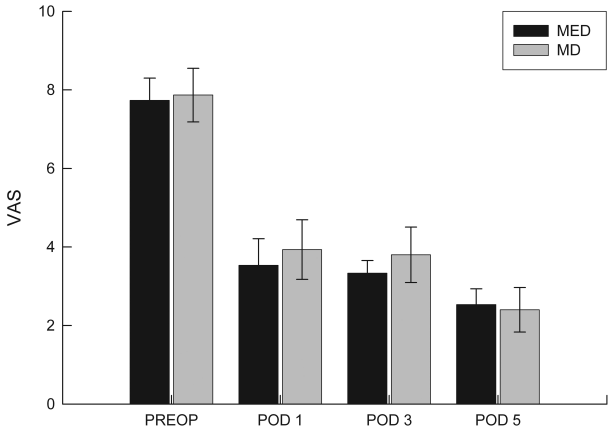

FIG. 4. Bar graph showing no significant differences in preoperative or postoperative VAS scores of leg pain between the two treatment groups at any time, indicating that decompression of the nerve roots was achieved equally well by both procedures.

of postoperative pain. The serum level of muscle enzymes is elevated during muscle injury, and this injury manifests itself as pain.[7–9,14] The CPK-MM level is a good indicator of paravertebral muscle injury after surgery because a significant amount of CPK-MM is contained in the skeletal muscle.[8] Among 5 isoenzymes of LDH, LDH-5 is highest in skeletal muscle.[2] Therefore, the authors used CPK-MM and LDH-5 serum levels as markers of muscular damage.

The data in this study showed that the MED group had significantly lower mean CPK-MM serum levels (at both 3 and 5 days postoperatively) and VAS scores of back pain (at both 1 and 5 days postoperatively) than the MD group. These data indicate that MED procedures cause less muscular damage than MD procedures, which results in reduced postoperative pain. Kotil and associates[9] reported that muscle injury during lumbar disc surgery is closely related to muscle retraction and relaxation times. Additionally, Kawaguchi and colleagues[6] reported that muscular damage during posterior spinal surgery is related to the retraction pressure and retraction time. In this study, operation time was the same in both groups and the investigators used the smallest size of tubular retractors (16 mm) for the MED procedures. Although the tubular retractor system avoids extensive muscle detachment, the Taylor retractor system used in MD procedures requires extensive muscle detachment and causes significant retraction pressure. These differences likely explain why MED causes less muscle damage and a smaller elevation of serum CPK-MM levels than the MD procedure. Unexpectedly, however, serum LDH-5 levels were not statistically different between the MED and MD groups, although LDH-5 levels may not be important because this enzyme exists in both the skeletal muscle and in the liver.

These results differ from those of Sasaoka and coworkers,[12] which show no differences in postoperative serum CPK levels between patients in the MED and MD groups. This discrepancy between different data might be attributable to factors such as different sampling dates and different peri- and intraoperative procedures. Sasaoka et al. evaluated CPK levels only until 1 day postoperatively, and our results also showed no differences between groups at this time point. However, our study also measured CPK-MM levels at both 3 and 5 days postoperatively, and we observed differences between groups at these times. Additionally, Sasaoka and colleagues did not provide a detailed description of the MED and MD procedures, and procedural differences such as the type of retractor, length of skin incision, and intramuscular injections used perioperatively may produce different results. Our results varied from those of Kawaguchi and associates[8] in terms of serum CPK-MM levels, which reached a maximum 1 day postoperatively in their study and 3 days postoperatively in our study. Suggested reasons for this difference include the use of patient-controlled analgesia in the first 2 postoperative days in our study, different dosages of a muscle relaxant, and the use of other unidentifiable medications.

There are limitations to our study, including a small sample size, a relatively long skin incision in the MD group, and a short observation period limited to hospital stays. Although there are various modified MD techniques that use smaller incisions, we intended to compare the MED procedure with a conventional MD procedure. It is understood that muscle injury occurs mostly during surgery, and this injury is most obvious in the immediate postoperative period.[7,8] For this reason, we restricted the observation period to the first 5 postoperative days. Given these study limitations, however, the data from the current study suggest that MED is a less invasive procedure than MD.

Conclusions

An MED procedure for iatrogenic muscle injury appears to be less invasive than an MD procedure, and causes less muscle damage and less back pain.

Disclaimer

The authors do not have any financial interest in any of the materials used in the current study.

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